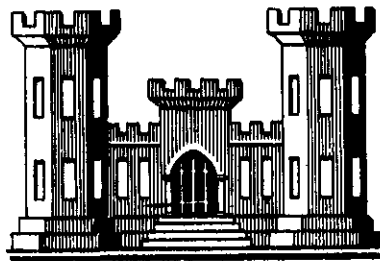


HURRICANE PROTECTION PROJECT

**FOX POINT
HURRICANE BARRIER**

PROVIDENCE RIVER, PROVIDENCE, RHODE ISLAND

**DESIGN MEMORANDUM NO. 1
SITE GEOLOGY**



U.S. Army Engineer Division, New England
Corps of Engineers Waltham, Mass.

OCTOBER 1959

ENGWE (9 Oct 59)

1st Ind

SUBJECT: /Design Memorandum No. 1, Geology for Fox Point Hurricane
Barrier, Providence, Rhode Island /

Office, Chief of Engineers, Washington 25, D. C. 6 November 1959

TO: Division Engineer, U. S. Army Engineer Division, New England
WALTHAM, MASS.

Design Memorandum No. 1, Geology, for Fox Point Hurricane
Barrier, Providence, Rhode Island is approved.

FOR THE CHIEF OF ENGINEERS:



F. B. SLICHTER
Chief, Engineering Division
Civil Works

Incl w/d

U. S. ARMY ENGINEER DIVISION, NEW ENGLAND

CORPS OF ENGINEERS

424 TRAPELO ROAD
WALTHAM 54, MASS.

EGS REPLY TO
HON ENGINEER

FILE NO. NEDGW

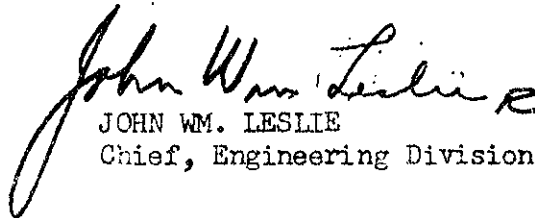
9 October 1959

SUBJECT: Design Memorandum No. 1, Geology, for Fox Point
Hurricane Barrier, Providence, Rhode Island

TO: Chief of Engineers
Department of the Army
Washington, D. C.
ATTENTION: ENGWE

In accordance with EM 1110-2-1150 there is submitted herewith for review and approval 10 copies of the Design Memorandum No. 1, Geology, for the Fox Point Hurricane Barrier, Providence, Rhode Island.

FOR THE DIVISION ENGINEER:


JOHN WM. LESLIE
Chief, Engineering Division

Incl (10 cys)
Des Memo No. 1,
Geology - Fox Point

FOX POINT HURRICANE BARRIER
PROVIDENCE
RHODE ISLAND

DESIGN MEMO NO. 1

GEOLOGY

INDEX TO DESIGN MEMORANDA

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1	Geology		
2	Hydrology Preliminary Final	3 June 1959	8 June 1959
3	Deleted		
4	Hurricane Tidal Hydraulics		
5	General Design Memo		
6	Embankment & Foundations		
7	Structural Section I		
8	Structural Section II		
9	River Gates		
10	Pumping Station		
11	Cooling Water Canal		
12	Sewer & Utility Modifications		
13	Providence River Studies		
14	Concrete Aggregates		

FOX POINT HURRICANE BARRIER

DESIGN MEMORANDUM NO. 1

SITE GEOLOGY

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Plate

PLAN OF FOUNDATION EXPLORATIONS
AND GEOLOGIC SECTION

FOX POINT HURRICANE BARRIER

PROVIDENCE RIVER

RHODE ISLAND

DESIGN MEMORANDUM NO. 1

SITE GEOLOGY

OCTOBER 1959

A. GENERAL

1. The purpose of this memorandum is to provide a geologic background for the design of a concrete barrier across the Providence River which will provide complete protection from hurricane flooding for the center of Providence. Appurtenant structures will include a pumping station, sluice gates for tidal interchange, flanking concrete walls, earth dikes and stoplogs, and a cooling water intake channel to service an existing generating plant which is situated upstream of the barrier.

B. GEOGRAPHY AND GENERAL GEOLOGY

2. Providence, Rhode Island, on the seaboard lowland, lies at the northern end of the Providence River estuary, a low velocity broad tidal stream which flows southerly into the upper reaches of Narragansett Bay. Much of the city's business center has been built on filled tidal areas hence is subjected to hurricane tidal flooding, while surrounding hills mostly comprising residential areas reach maximum elevations of about 200 feet on the east and 300 feet on the west. The western hills are higher because they mark the eastern edge of a mass of very old resistant crystalline rocks which lies outside of the Narragansett Carboniferous Basin. Providence, on the other hand, lies within the northwestern edge of the basin, which is a structural depression containing soft metamorphosed sedimentary rocks which have managed to survive long periods of denudation and planation. Earth crustal movements, however, did ripple and contort the Carboniferous rock beds, leaving most of them standing nearly on end, presenting irregular surfaces of varied composition beneath the glacial sediments which mask them.

C. SITE GEOLOGY

3. Fox Point is a short V-shaped peninsula consisting partly of man-made fill, lying between the Providence and Seekonk rivers where the latter, flowing from the northeast, joins the southward flowing Providence River. Between the rivers, rising gently to the northeast from Fox Point, is a till and rock hill whose toe forms the east abutment of the protective dikes. The concrete barrier will cross Providence River a short distance north of Fox Point and abut west of the river on filled flats belonging to the Narragansett Electric Company. The ship channel, once in the middle of the river, now borders this western shore because of extensive filling to the pier and bulkhead line. The fill consisting of ashes, coal, earth, and oyster shells, has provided an extensive tract of industrial land. Dikes and walls will traverse the industrial fill as an extension of the barrier, cross a main artery, Allens Ave., and terminate a short distance westward at higher elevation, where the original ground toe of another hill meets the old shoreline. The east abutment, on the other hand, is near original ground, although a considerable thickness of fill occurs at and near the bulkhead. Part of the fill consists of dredged materials which make it difficult to determine with certainty the boundary between granular fill and original shore or river bottom materials. Downstream from the east abutment the tip of Fox Point consists of fills projected a considerable distance from the original shoreline.

4. The substrata in this portion of the Providence River are fairly well known. Bedrock lies about 110 feet below sealevel, covered with a few feet of sandy glacial till containing weathered rock, a stratum of inorganic silt resembling rock flour, then a layer of gravelly sand which is silty and till-like in part, and, finally, a blanket of geologically recent soft organic silts and clays attaining a maximum thickness of about 30 feet under the fill near the west abutment.

5. Bedrock under the river crossing consists of black coaly (meta-anthracite) shale beds interbedded with sandstone dipping at approximately 45° in unknown orientation. Bedding-dips of bedrock outcrops in the area are generally easterly and it appears likely those beneath the river are easterly since no unconformable situations were revealed and the dip angles were consistent. Considerable surface irregularity exists and both types of rocks have been encountered in several borings, although the black shales predominate. A considerable depth of decomposed rock (more than 30 feet) was encountered at the southeast end of Fox Point, but generally the rock is moderately fresh (although not strong) near the surface. Occasional small solution cavities occur in the sandstone and some minor secondary mineralization appears on fracture planes in the black shale, with a few thin quartz veins intersecting the shale contrary to the bedding dip. The possibility that some

of the shale could be reactive with concrete is under investigation and a mud and river water testing program was instituted to determine the nature of the chemical environment of the river water and harbor mud with respect to steel sheet piling and concrete durability.

D. CONSTRUCTION CONSIDERATIONS

6. It is expected to overcome the foundation problem offered by the thick organic silt deposit under the river by dredging and spoiling materials down to about elevation -40 feet, M. S. L., and to replace the undesirable materials with granular borrow up to a workable level which will provide an adequate supporting blanket contiguous with the underlying gravelly sand stratum (see Plate I).

E. FOUNDATION INVESTIGATIONS

7. Private and public interests have necessitated foundation studies at the present site and a location downstream (see Plate I). In addition, two borings were made upstream off South Street in 1956. Sixty borings were made in all, including eleven borings involving undisturbed sampling. Other explorations included hand auger borings and drive-hammered probings.

F. AVAILABILITY OF CONSTRUCTION MATERIALS

8. The metropolitan situation of Fox Point poses problems in obtaining and trucking borrow materials. Access from the west and north sides is severely restricted because of city congestion, while borrow pits very near to the site are largely depleted.

9. Impervious Earthen Borrow for Dikes. An area of glacial till, located 5 miles from the site, south of County Street in Seekonk, Mass., has been selected for exploration (see Vicinity Map, Plate I).

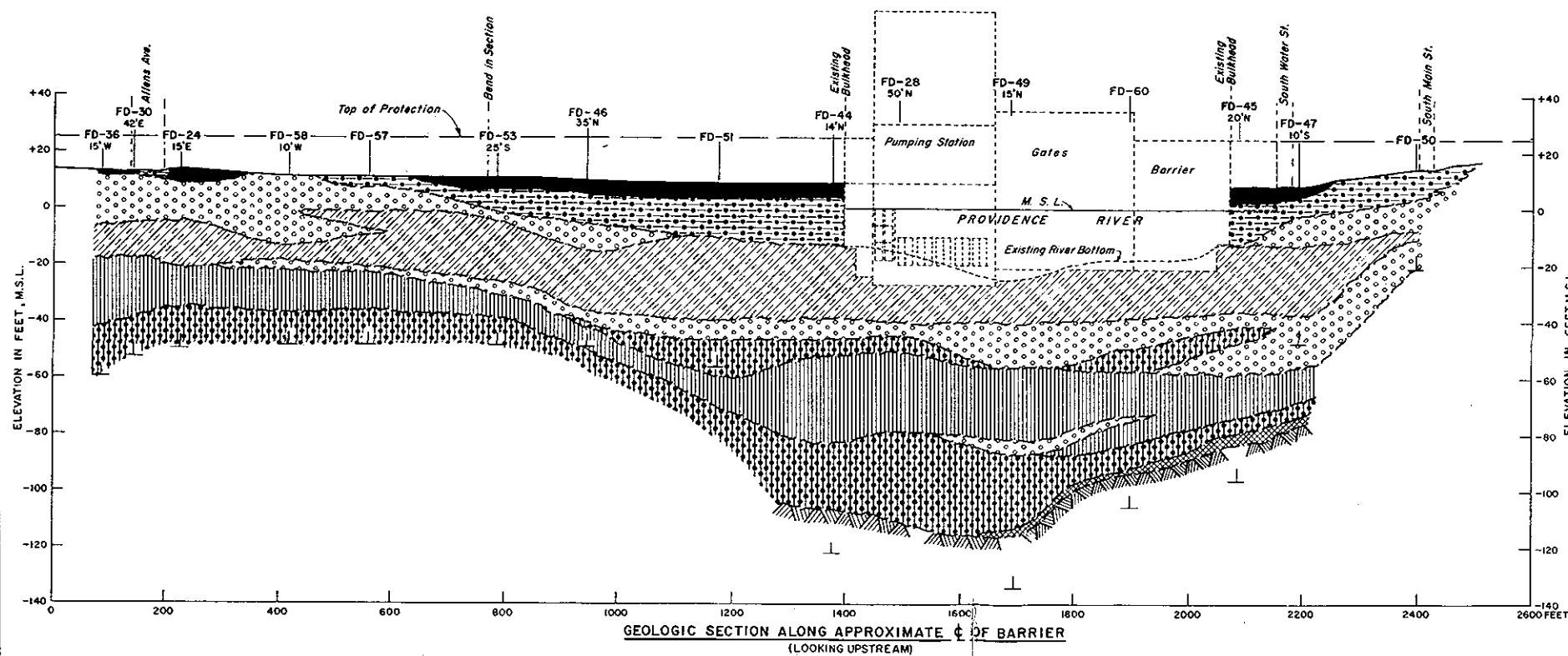
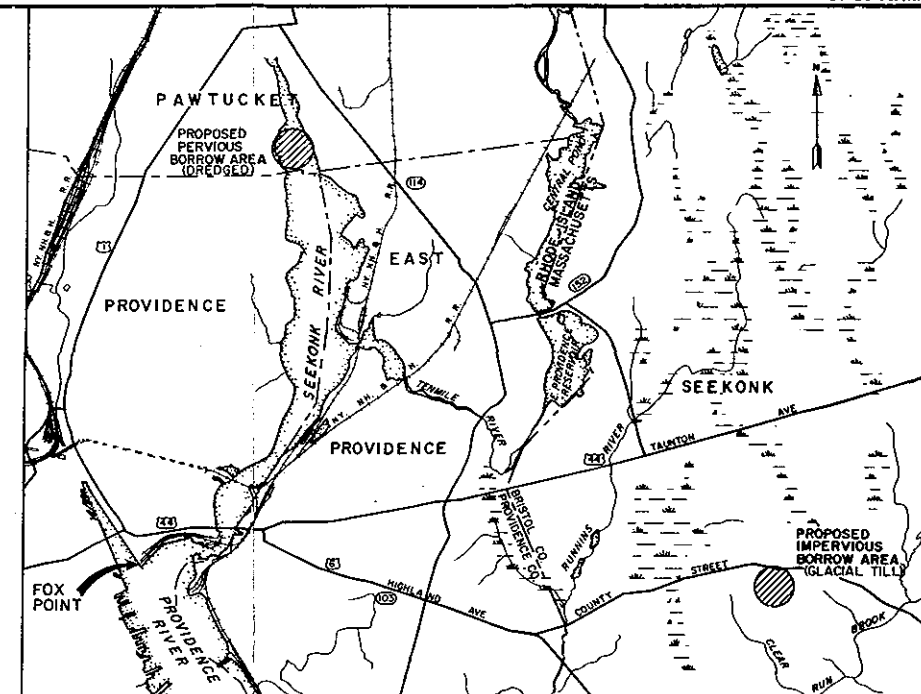
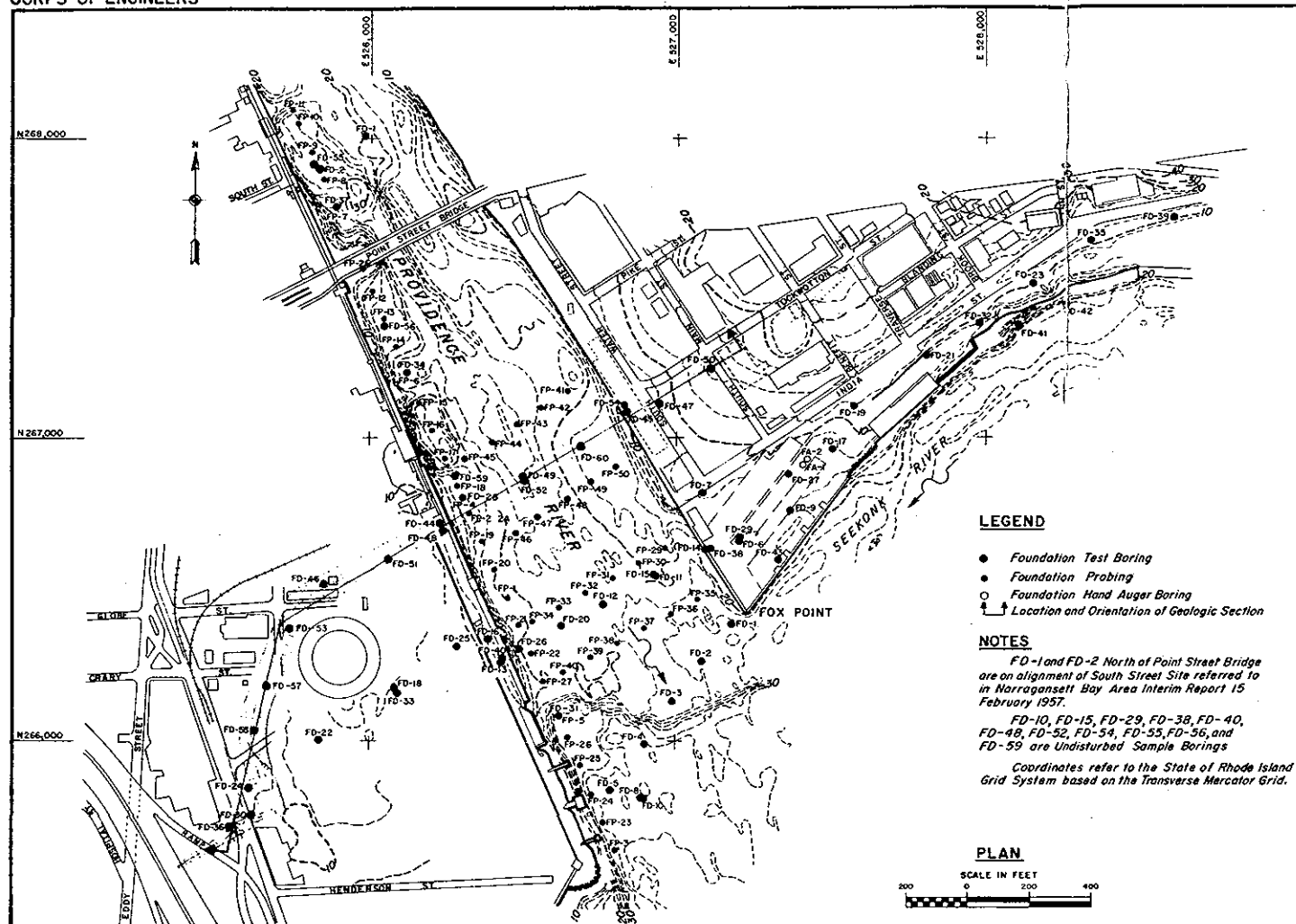
10. Granular Materials for Foundation and Other Fills. Attempts were made to locate granular materials on city-owned land, which would be suitable for replacing organic silts under the main barrier and for use in cofferdam cells and pervious dike sections. Four borings were made in Blackstone Park, less than two miles from the site, and three borings in an area north of Fields Point, 1.5 miles from the site. The materials in both areas proved to be too fine. Fourteen borings were located in the Seekonk River revealing an adequate supply of suitable sands and gravels, located about 3.5 miles scow distance from Fox Point. Five additional borings are being made to further define the area (See Vicinity Map, Plate I). It is expected that this area will be made available with

contractor's option to use any other source of his own selection which meets gradation requirements. Reconnaissance of the area indicates that undeveloped and commercial sources exist within reasonable truck haul distance.

11. Rip-Rap and Armor Stone. Two local sources of stone have been investigated. Gammino's Quarry, six miles southwest of the site, in Knightsville, involves truck haul through the city. The quarry is newly opened and the stone, a closely fractured schist, is not sufficiently exposed to reveal possible better characteristics. It is not known whether the quarry will have an adequate working face in time for bidding on this project or if the material will prove suitable. The second source, Fanning and Doorley Quarry, lies 8.5 miles north of the site in Berkeley. The rock is a rather fine-grained metamorphic product in its best phase, while other areas indicate bedded non-granitized metamorphic phases. Most of the existing 100-foot face exhibits considerable weathering on fairly close and intersecting joint planes and one area of the quarry is extremely weathered. Use of this quarry, if approved, will require careful selection of areas.

12. It is expected that the larger commercial sources of stone from as far distant as Connecticut and eastern Massachusetts will furnish competitive prices at the site.

13. Concrete Aggregates: Commercial sources of concrete aggregates within 20 miles of the site have been sampled and tested. Competitive sources of aggregates within 10 miles haul distance from the site are expected to meet final approval. A detailed discussion of concrete aggregates will appear in Design Memorandum No. 14, Concrete Materials.

**LEGEND**

- Coaly fill - (20/ft., range 1 to 70)*
- Earth, bricks, rubble, and oyster shells (fill) - (5/ft., range 2 to about 20)
- Sands, gravelly sands and gravel, largely silty, with cobbles in part, and occasional silt seams - (range 0 to 30*)
- Silts and clays, mostly organic - (3/ft., range 0 to 10*)
- Inorganic silts - (10/ft., range 0 to about 30)
- Glacial till and till like material - silty sandy gravel, silty gravelly sand, largely with cobbles, clayey in part - (50/ft., range 7 to 100*)
- Decomposed bedrock
- Bedrock - coaly shale interbedded with sandstone. Approximately 45° bedding dip.

NOTE

* Figures in parentheses refer to the approximate averages and general ranges of blow counts required per foot of penetration usually of a 2 1/2" or 3" O.D. sample spoon driven by a 300 or 350 pound hammer with a free fall of about 18 inches.

DES. BY C.E.H.	DR. BY H.C.S.	CH. BY H.C.C.	DATE OCT. 1959
U.S. ARMY ENGINEER DIVISION, NEW ENGLAND CORPS OF ENGINEERS WALTHAM, MASS.			
FOX POINT HURRICANE BARRIER			
PLAN OF FOUNDATION EXPLORATIONS AND GEOLOGIC SECTION			
PROVIDENCE		RHODE ISLAND	
SCALE: AS SHOWN			
DRAWING NUMBER FP-1-1000			
SHEET 1 OF 1			